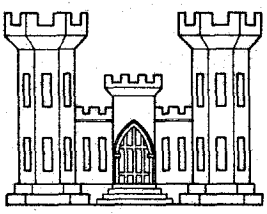
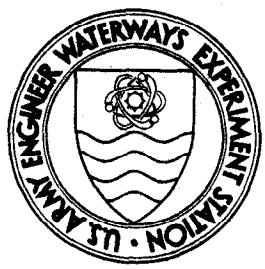


DREDGED MATERIAL RESEARCH PROGRAM



MISCELLANEOUS PAPER D-76-13

DREDGED MATERIAL AS A NATURAL RESOURCE--CONCEPTS FOR LAND IMPROVEMENT AND RECLAMATION

by

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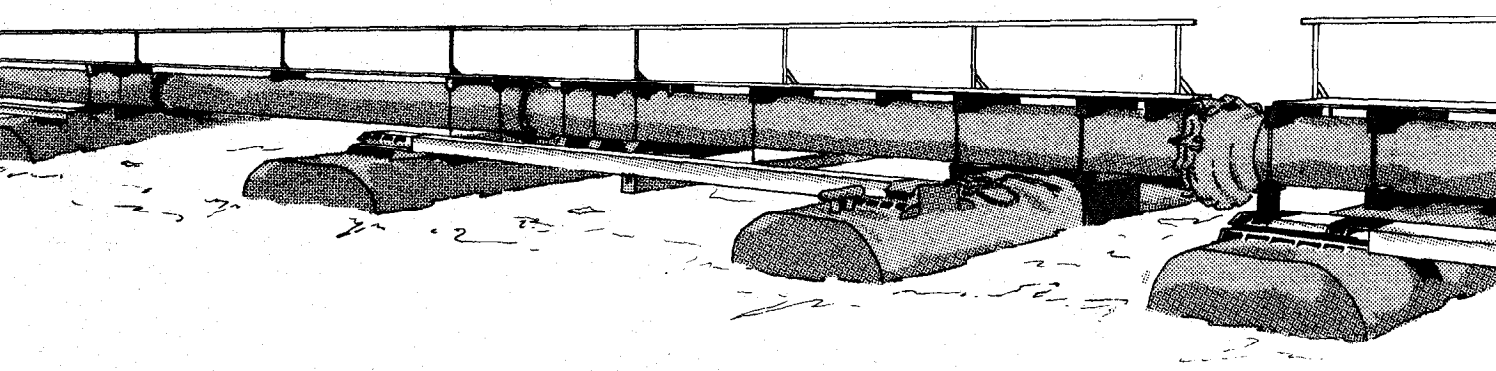
March 1976

Final Report



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Maintenance of navigation in the Nation's waterways requires the annual dredging of more than 400 million cubic yards of estuarine, lacustrine, and riverine sediments. Typically, the dredged material is fine grained and a significant fraction contains various contaminants originating from urban, industrial, and/or agricultural runoff. Because of the pollution potential of such material, it must be confined on land rather than disposed of in open water. Considering the small percentage usable as construction material and the poor (Continued)

20. ABSTRACT (Continued)

foundation conditions afforded at the containment facilities, this disposal alternative aggravates the conflict between waste disposal and productive land use. As part of the Corps of Engineers' comprehensive Dredged Material Research Program, various avenues are being explored for productive uses of dredged material, with or without mechanical or chemical treatment. Several studies have been initiated seeking ways to use the fine-grained, low-density, high-water-content, nutrient-rich characteristics as assets rather than liabilities. These include using the material for strip mine reclamation, filling abandoned pits or quarries, cover for sanitary landfills, and agricultural land enhancement. Initial investigations are concentrating on aspects relevant to any related use, i.e., relatively long distance transport systems (including collection and distribution subsystems) involving pipeline, rail, barge, and other modes; and geochemical and geohydrological considerations of leachate and groundwater contamination potential. Both initial and subsequent studies will seek to identify limiting factors and relevant parameters, whether they be technical, economic, social, political, or other, and to develop decision making methodologies.

PREFACE

This paper represents a slightly modified (edited for publication) version of a presentation made in the technical session entitled, "Environmental Geology," held on 20 October 1975, as part of the 1975 Annual Meeting of the Geological Society of America, Salt Lake City, Utah.

The topic of the paper basically reflects the research philosophy and goals of the Productive Uses Project of the Corps of Engineers' Dredged Material Research Program (DMRP). Planning and management of the DMRP are being accomplished at the U. S. Army Engineer Waterways Experiment Station (WES) by the Environmental Effects Laboratory (EEL) under the direction of Dr. John Harrison, Chief. Dr. R. T. Saucier, Special Assistant for Dredged Material Research, EEL, prepared this paper. CPT R. M. Meccia, Project Manager, Productive Uses Project, and Mr. M. R. Walsh, Project Manager Assistant, provided much of the information on which the paper is based and furnished most of the illustrations. Mrs. Mary K. Vincent, EEL, edited the paper for publication.

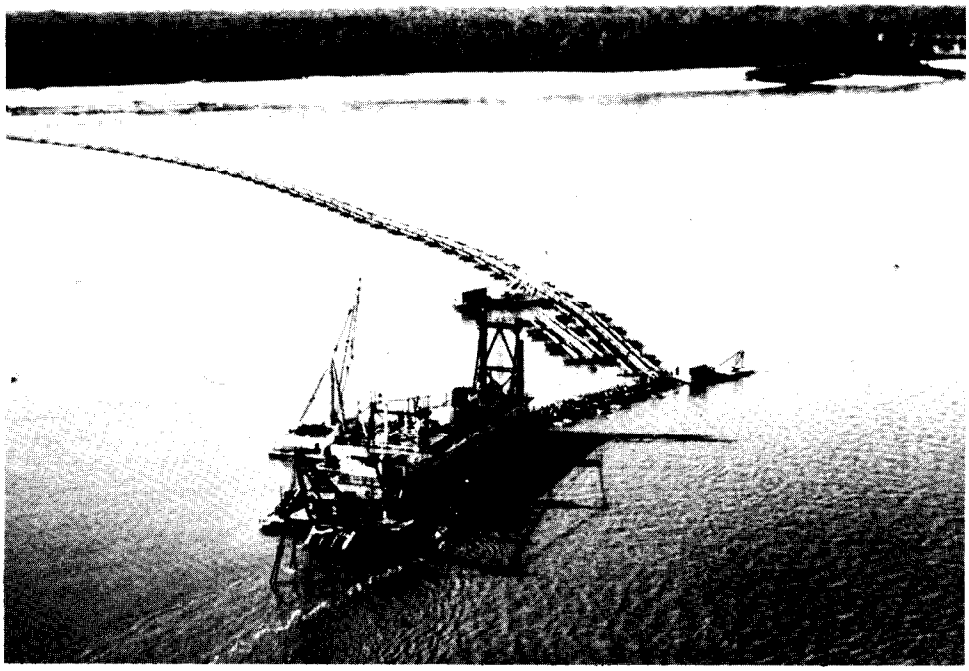
Director of WES during the preparation of this paper was COL G. H. Hilt, CE; Technical Director was Mr. F. R. Brown.

CONTENTS

SIGNIFICANCE OF DREDGING

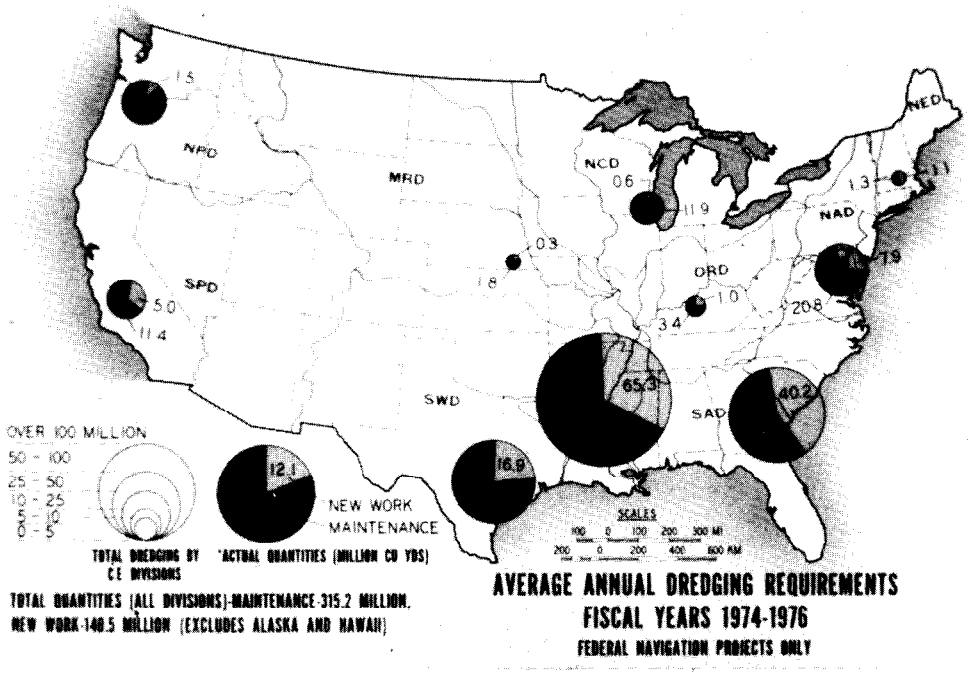
While earth moving operations such as this are observed virtually daily, it is doubtful, even in this age of environmental awareness, that anyone stops to comprehend the degree to which man is literally changing the face of the earth. Considering the diversity of the operations, which include land leveling, cutting and filling, mining and quarrying, dam and reservoir construction, and numerous others, the cumulative physiographic effect is startling.

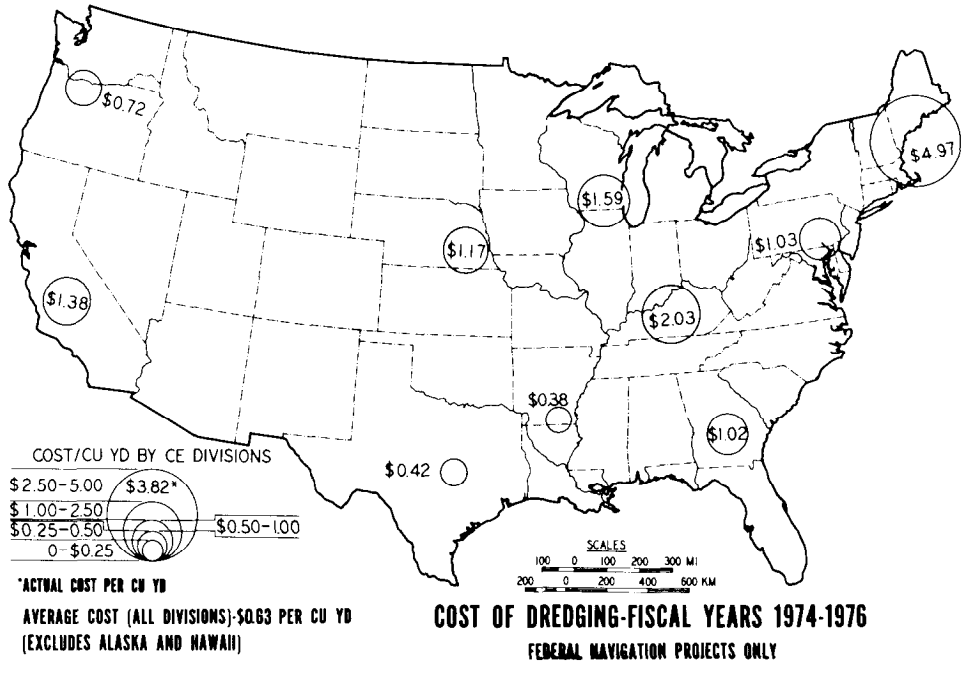
Dredging is probably the least known and popularized earth and rock moving method, but it is certainly one of the most widespread and consequential ones. An often overlooked, but significant aspect of dredging is the fact that the hydraulic cutterhead pipeline dredge is one of the most efficient excavation methods devised by man.



Dredging Requirements

Dredging is accomplished for a variety of purposes such as landfill construction, pipeline construction, and aggregate production, but without a doubt, the principal purpose is the creation and maintenance of waterways for commerce, recreation, and defense. Considering only federally sponsored projects, the amount of sediment dredged annually is enormous—now averaging over 450 million cubic yards. It comes from about 25,000 miles of waterways and several hundred ports and harbors; were it all placed on land, it could cover the entire State of Delaware to a depth of 3 feet in 20 years. Fortunately, most dredged material is disposed of in open water but that being placed on land for one reason or another creates a demand for about 7000 acres of new disposal sites each year.





Dredging Costs

To perform the volume of dredging just shown costs the United States taxpayers nearly $300 million per year. Dredging costs are influenced by the types and quantities of sediment moved, the types of dredges used, and the nature of the operational environment; however, often these are much less important than the influence of the location and mode of disposal of the dredged material. A decade ago, the national average unit cost of dredging was about 50¢ per cubic yard. As this illustration shows, the large dredging projects in the Gulf Coast and Lower Mississippi Valley areas, largely involving easily dredged silts and sands, still average less than 50¢ per cubic yard, but the national average is substantially above this amount.

Confined Disposal Facilities

Without question, the single most important cost-influencing factor in this cost rise, manifested most noticeably in the Great Lakes, North Atlantic, and New England areas, has been the need to place contaminated or feared-to-be-contaminated dredged material on land behind dikes.

Confined disposal facilities are expensive: Even ones a few tens of acres in size built with riprap-protected earthen dikes can cost several million dollars.

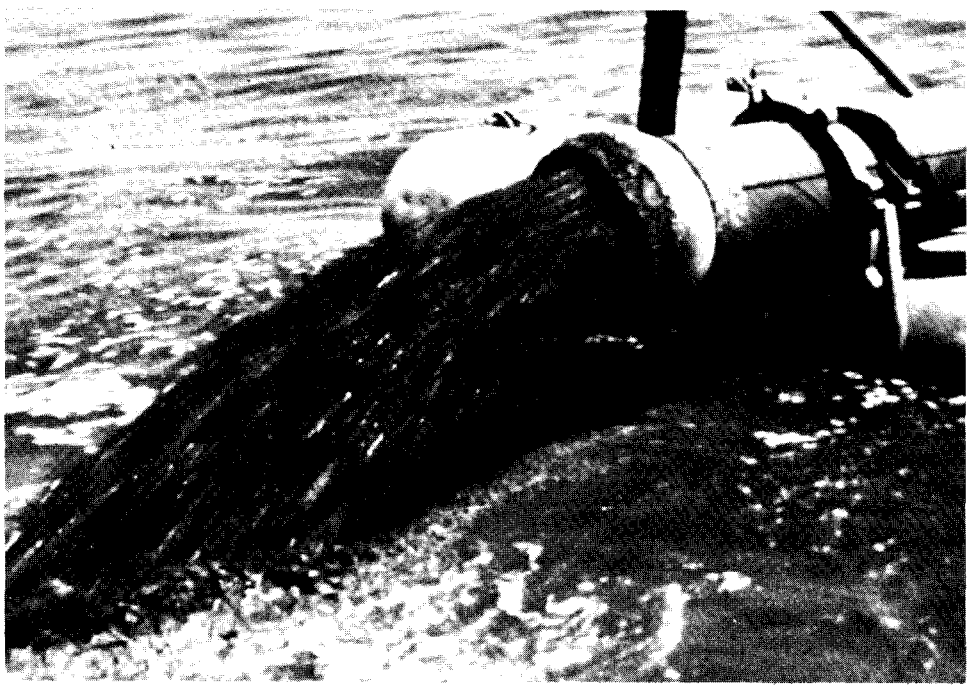
The land on which they are built, often located near large urban centers, is expensive to acquire. Moreover, the use of large acreages of such land for a waste disposal-type activity is often incompatible with good land use and land management practices.

At one time, most disposal sites were built on marshes or other coastal wetlands since these areas had the lowest land values and were least in demand for economic development. Needless to say, this practice is essentially nonexistent today because of national policy which recognizes the ecological value of such areas.

Unless unusually well managed, disposal sites are not particularly attractive areas. They can produce odors, become breeding grounds for mosquitos and undesirable wildlife, and be dumping grounds for other types of solid waste.

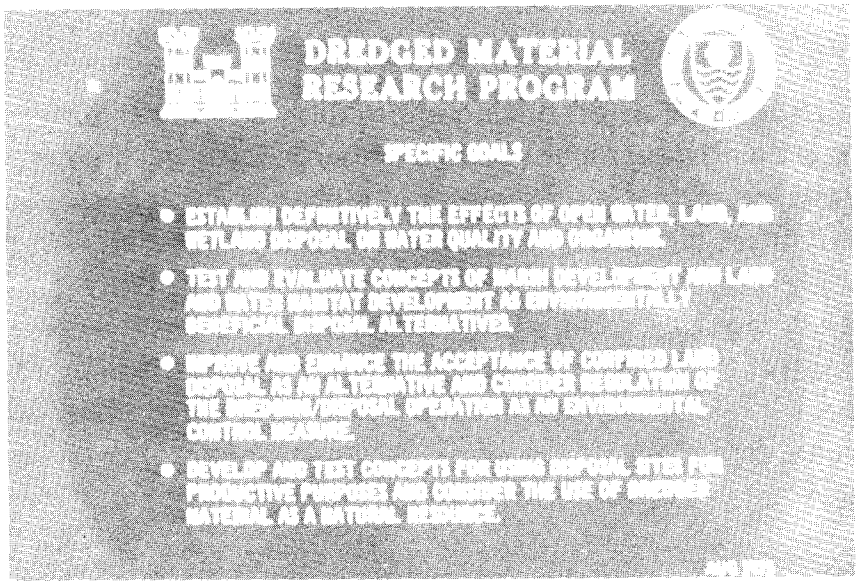
Necessity of Dredging and Disposal

But dredging and confined disposal are necessary evils, so-to-speak, for these reasons: waterborne commerce is vital to the economic viability of the Nation and there is no alternative to dredging to maintain waterways. In spite of pollution abatement programs, industrial and urban discharges and runoff continue to contribute toxic substances such as heavy metals, polychlorinated biphenyls, pesticides, and hydrocarbons to our waterways. These substances become affiliated with the sediments that ultimately form the shoals that must be dredged. At present, there are no satisfactory alternatives to protecting the environment from the effects of truly contaminated dredged material other than to place it in confined areas.



DREDGED MATERIAL RESEARCH PROGRAM

To find satisfactory and cost effective alternatives is one objective of the multimillion dollar, nationwide Dredged Material Research Program now being accomplished by the Corps of Engineers. Specific goals involve trying to determine what are the truly adverse effects of all types of disposal activities and, as far as land disposal is concerned, to make this practice as effective and efficient as possible. Major attention is being focused on either avoiding the need for confined disposal facilities or extending the life of disposal facilities by finding productive uses for the material.

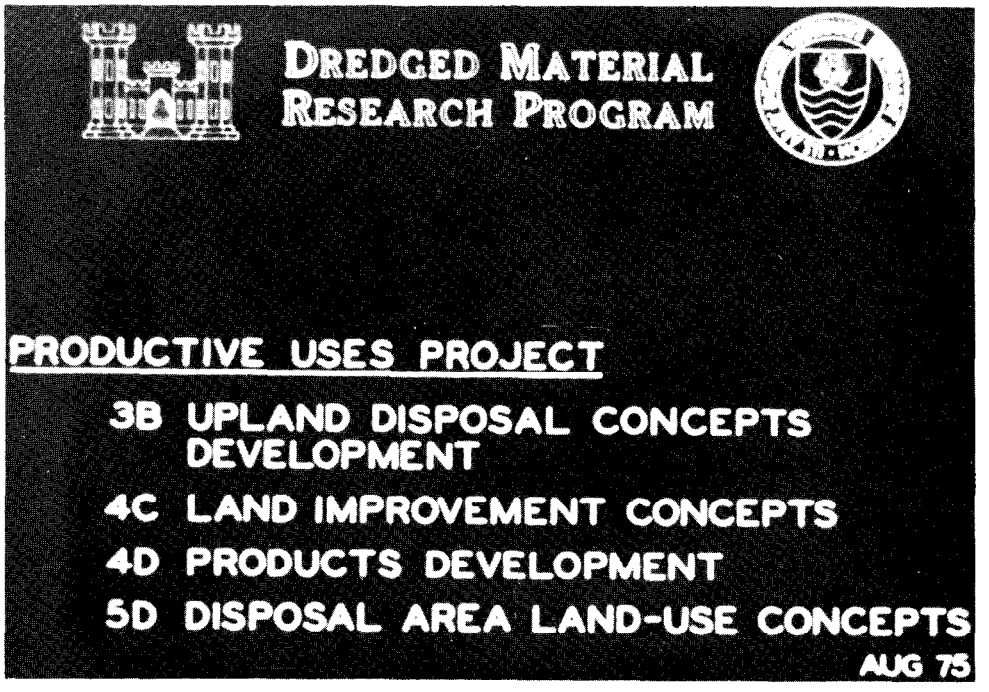


Obviously, consideration is being given to the use of dredged material for landfill and construction purposes; however, little of it is sufficiently coarse-grained to be suitable for this. In addition, production economics, market conditions, and sometimes even legal and institutional factors are not always favorable. But so as not to overlook any possibilities, extensive and varied research and development activities are looking at ways of dewatering, separating, and even treating dredged material to make available useful fractions wherever there is a demand.

To pursue another promising alternative, an intensive research effort is being directed toward using particularly the finer grained and organic-rich dredged material for the deliberate creation of wetlands. As this photo taken recently at a test site in Virginia illustrates, this is a viable alternative, but wetlands can neither be built nor are desirable in many locations. Consequently, more productive alternatives need to be identified, especially for the tens of millions of cubic yards of fine-grained, high-water-content, nutrient-rich, and sometimes mildly contaminated sediments that are accumulating.

PRODUCTIVE USES PROJECT

Can this material be a natural resource—alleviating disposal problems and being used productively at the same time? This is an objective of the Productive Uses Project, one of four projects comprising the Dredged Material Research Program, and is being pursued under Tasks 3B and 4C.



Use in Pits and Quarries

An apparent alternative that is a relatively simple concept yet surprisingly one that is not known to have ever been tried is the use of dredged material to fill abandoned pits and quarries. Numerous locations of this type occur within and peripheral to major urban areas and their dredged ports, and are exemplified by this pit in the Chicago area that may become the first to be used in this way. It has the capacity to hold more than 10 years of dredging output and its filling unquestionably will improve the land and the surrounding residential area.

If a single reason could be cited as a factor inhibiting the implementation of this concept, it would certainly be the fear of possible groundwater contamination. While major progress has been made in understanding the mechanisms of chemical contaminant migration or mobilization from dredged sediments during open-water disposal, the same cannot be said with regard to confined disposal areas.

Groundwater Contamination Study

To overcome this deficit in knowledge, a research contract is about to be let for a major study of the leachate from both dredged material alone and dredged material complexed with other forms of solid waste. Dredged material of a range of physical and chemical characteristics will be placed in leaching columns or lysimeters under conditions designed to simulate a range of groundwater conditions. Leachate quality will be assessed and related to dredged material characteristics so that the potential for groundwater contamination can be predicted, thereby establishing limits of feasibility or dictating the need for mitigative measures such as impervious pit liners or selective filling. Information from this study, like the results of much of the research program, will be combined with site-specific information and used by decision makers in the District offices of the Corps for deciding on a satisfactory disposal alternative.

Use in Sanitary Landfill

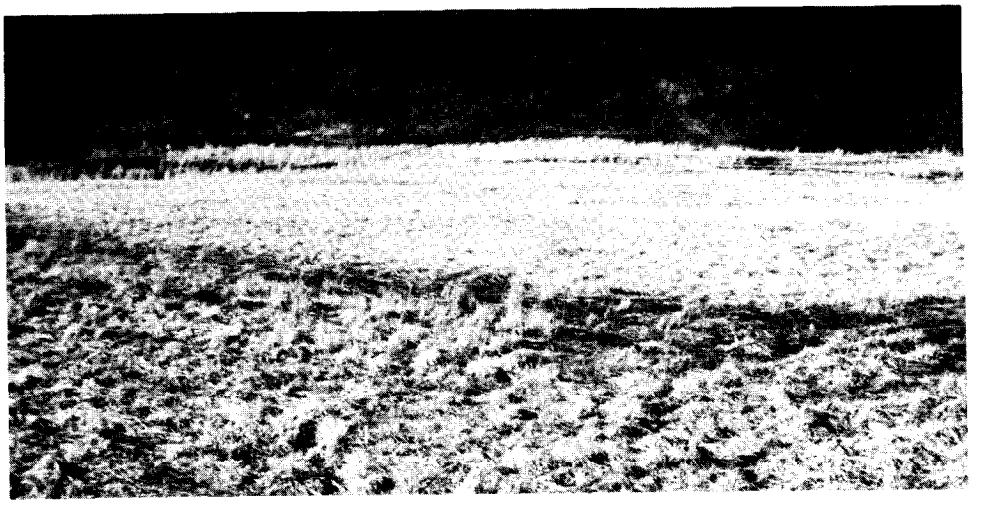
Results from the leachate study will be directly applicable in evaluating another beneficial alternative, that is, using dredged material for cover in sanitary landfill operations. Lack of suitable cover material in adequate quantities often has been a deterrent to large centralized landfills as effective urban waste management systems, and in some cases, cover material must be purchased at a cost of several dollars per cubic yard. Can dredged material be used for this purpose? To find out, a study is being initiated to define landfill cover requirements and to identify controlling operational factors such as stockpiling, distribution, and application.

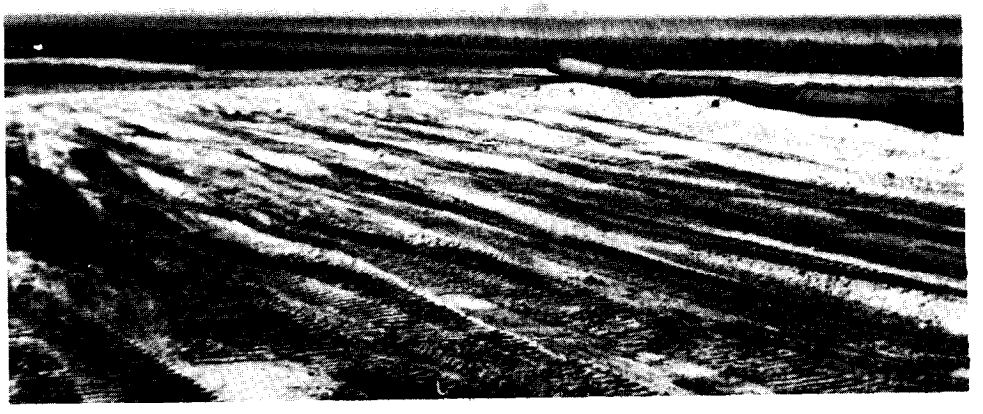
Use in Strip Mine Areas and Refuse Banks

An intriguing possibility for productively using large quantities of dredged material is the concept of reclaiming strip mined areas or revegetating refuse banks. Undoubtedly, everyone is aware of the magnitude of this problem and the extent of opportunities it affords.

Generally speaking, a soil suitable for reclamation must be nonacidic, have a good moisture holding capacity, be nutrient rich, and be resistant to rill wash. In tests conducted by the U. S. Bureau of Mines and others, success has been achieved by using fly ash and sewage sludge as soil amendments, such as in this view in West Virginia. In a cooperative effort with this agency, the feasibility of using dredged material for this purpose is being explored preliminarily in greenhouse experiments. Results will dictate the nature of possible follow-on investigations.

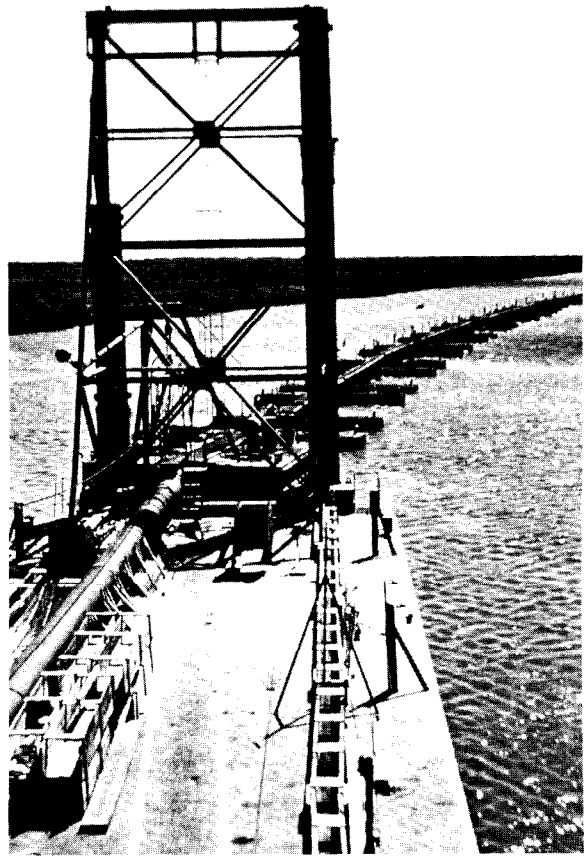
Initially, the mine reclamation concept appears viable for dredged material from freshwater areas and that which is relatively free from chemical contamination. Results of studies of the land application of sewage sludge and wastewater suggest that the addition of a few inches of dredged material containing low concentrations of heavy metals should not produce significant bioaccumulation or other deleterious effects.



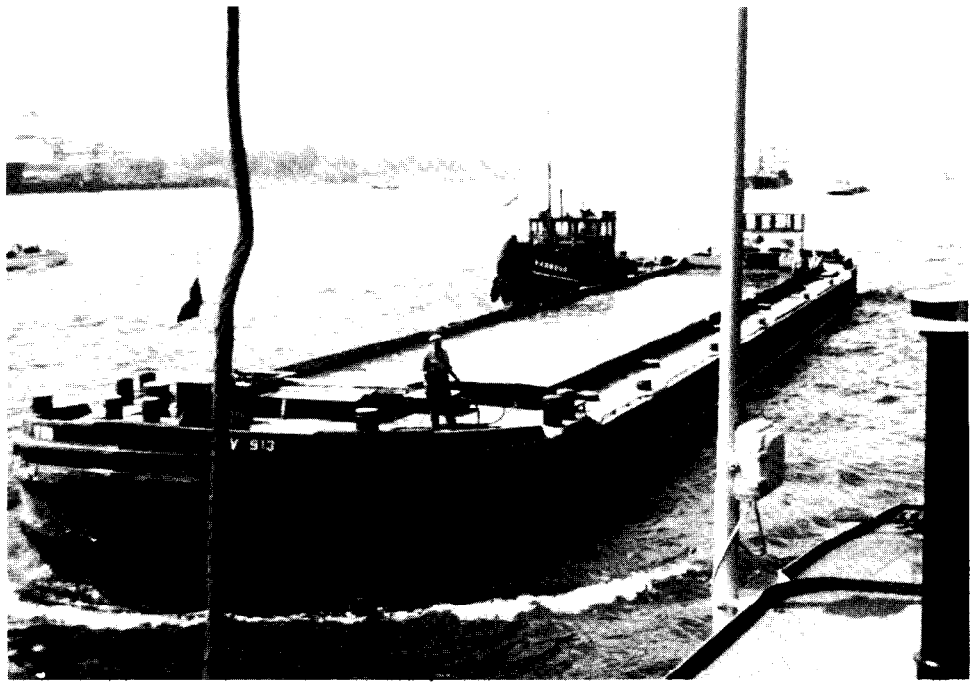


Transport Studies

A recognized major constraint on the application of this concept is the transport of the dredged material from the dredging site to the mine site. Present pipeline dredges seldom have the capability of pumping distances greater than a few tens of thousands of feet and transport of material by scows is restricted to waterways and distances of a few tens of miles. A major study will begin shortly to assess the limits of feasibility of conventional transport modes and to develop procedures for analyzing the costs and limitations of various combinations that could be used to form a long-distance transport system, that is, up to distances of a few tens of miles.



In view of the number of proven transport modes available, feasibility is expected to be essentially a matter of economics. Ores in slurry form can be transported hundreds of miles by pipeline. Similarly, ores in slurry or dry form can be transported by truck, rail, or water if there is a demand. Not to be overlooked in the study will be the tens of thousands of railcars that now return empty from the coal shipping ports to the mines.



Use in Agriculture

The most technically involved and sociopolitically influenced concept being considered is the use of dredged material for agriculture and agricultural land enhancement. While disposal sites have been used in some areas for years for crop production, such as this one producing vegetables in South Carolina, the mere mention of the use of dredged material for this purpose in other cases brings outcries of fear and accusations of poisoning of human foodstuffs with toxic sludges.

CONTAMINANT UPTAKE

The matter of the uptake of contaminants by crops is an extremely complex one with little really useful data available. The Dutch have intensively farmed disposal areas such as this one with no apparent toxic effects from moderately contaminated material. However, in other cases they have experienced mortality in livestock because of the bioaccumulation of copper and zinc by

forage crops. Several studies have been conducted in the United States and Canada and have only concluded that the uptake of elements is more dependent on the plant species than the sediment character, that different plant tissues accumulate different quantities of elements, and that states of water and nutrient stress will vary the uptake from one plant to another of the same species on the same sediment.

The research approach being planned will seek to combine existing information from ecosystem modeling and other sources with limited scale greenhouse or field experiments to identify worst-case situations. Realizing fully that certain material will be too contaminated to be considered for use safely, this still leaves a significant potential.

GREENHOUSE EXPERIMENTS

There are numerous locations where additional arable land is needed and even more where fairly sterile soils need improvement. In demonstrations performed several years ago using sandy Coastal Plain soils from New Jersey, the benefits of mixing with dredged material were dramatically illustrated.

As little as 30 percent fine-grained organic dredged material produced these results. In other studies, it has been found that crop yields of corn, tomatoes, and several types of peas and beans could be increased 30 to 50 percent by adding dredged material as a natural fertilizer.


NO FILL
+LIME
+FERT.


30% FILL
+LIME
+FERT.

SUMMARY

In summary, a major research effort is under way to try to determine when it must be like this...

...rather than like this, a reclaimed mine area. As progress is made and technological gaps are defined, it is becoming more and more apparent that the answer is simply "No one has needed to try to find out." Consequently, the job is both technical and promotional in that the Dredged Material Research Program must sell concepts and arouse interest in new ideas and alternatives.

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